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Effect of high voltage electrical discharge treatment and drying on properties of cocoa shell

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Introduction

Cocoa bean shell is a by-product of a chocolate industry that is separated from cocoa beans before or after roasting. It is rich in fibres, proteins, and bioactive components and a potential material for the enrichment of nutritionally poor food products. Since the shell is exposed to external factors during the whole processing of the beans, it can be contaminated with different microorganisms, toxins, polycyclic aromatic hydrocarbons, acrylamide, 5-hydroxymethylfurfural, etc. High voltage electrical discharge treatment (HVED) is known to reduce some of those contaminants. HVED is conducted in water by generating electrical discharge (emission of different radicals and UV-light) between two submerged electrodes. After the treatment, drying of the treated material is needed. In this study, we examined the influence of freeze- and oven drying of HVED-treated cocoa shell on water activity, water and oil binding capacity, colour, and total phenolic content.

Materials and methods

Sample preparation

- Separation of cocoa shell from fermented and roasted cocoa beans.
- Control sample – milled untreated cocoa shell (UCS)
- Water control samples - mixing in water for 10 min, freeze drying (WFCS) or oven-drying at 60 °C (WDCS)
- High voltage electrical discharge (HVED) treated samples – 70 Hz, 10 min, concentration 0.5%, freeze drying (WFCS) or oven-drying at 60 °C (WDCS)

Color

- Measurements were conducted with chromameter Konica Minolta CR-400 in the LCh and CIEL*a*b* system.
- L* shows lightness, a* red or green colour and b* yellow or blue, L_0*, a_0* and b_0 * are values for control sample.
- Total colour change (ΔE) (1) was calculated according to:

$$\Delta E = \sqrt{(L-L_0)^2 + (b-b_0)^2 + (a-a_0)^2} \qquad (1)$$

Water activity

- Measurement of water activity in two repetitions
- HydroLab 3 calibrated in 0.000 to 1.000 aw range

Water and oil binding capacity

- Water binding capacity (WBC) and oil binding capacity (OBC) were determined using AACC Method 88-04

Total phenolic content

- Folin-Ciocalteu method was used
- 100 µL of extract, 6 mL of water and 500 µL of undiluted Folin-Ciocalteu reagent were mixed, after 6 min 15000 µL of 20% Na_2CO_3 was added
- Mixtures were left in dark for 2 h after which absorbance was measured at 760 nm against blank

Table 2. Water activity (a_w), water (WBC) and oil (OBC) binding capacities of cocoa shell samples

Sample	a_w	WBC (g/g)	OBC (g/g)
UCS	0.471 ± 0.002	5.288 ± 0.038	1.598 ± 0.013
WDCS	0.153 ± 0.001	6.237 ± 0.056	1.578 ± 0.000
HDCS	0.057 ± 0.001	6.575 ± 0.086	1.523 ± 0.072
WFCS	0	6.047 ± 0.062	2.054 ± 0.043
HFCS	0	6.136 ± 0.012	2.031 ± 0.085

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Results

Table 1. Color parameters and total color change of cocoa shell samples

Sample	L*	a*	b*	C	h°	ΔE
UCS	46.72 ± 0.00	9.59 ± 0.03	18.72 ± 0.02	21.03 ± 0.02	62.86 ± 0.09	
WDCS	47.03 ± 0.01	8.48 ± 0.01	17.15 ± 0.03	19.13 ± 0.03	63.68 ± 0.04	1.94 ± 0.02
HDCS	44.18 ± 0.01	8.77 ± 0.03	16.47 ± 0.03	18.66 ± 0.03	61.96 ± 0.11	3.49 ± 0.02
WFCS	46.28 ± 0.09	8.53 ± 0.07	17.17 ± 0.04	19.18 ± 0.01	63.58 ± 0.22	1.93 ± 0.02
HFCS	47.91 ± 0.02	8.33 ± 0.05	16.96 ± 0.03	18.90 ± 0.03	63.85 ± 0.16	2.47 ± 0.03

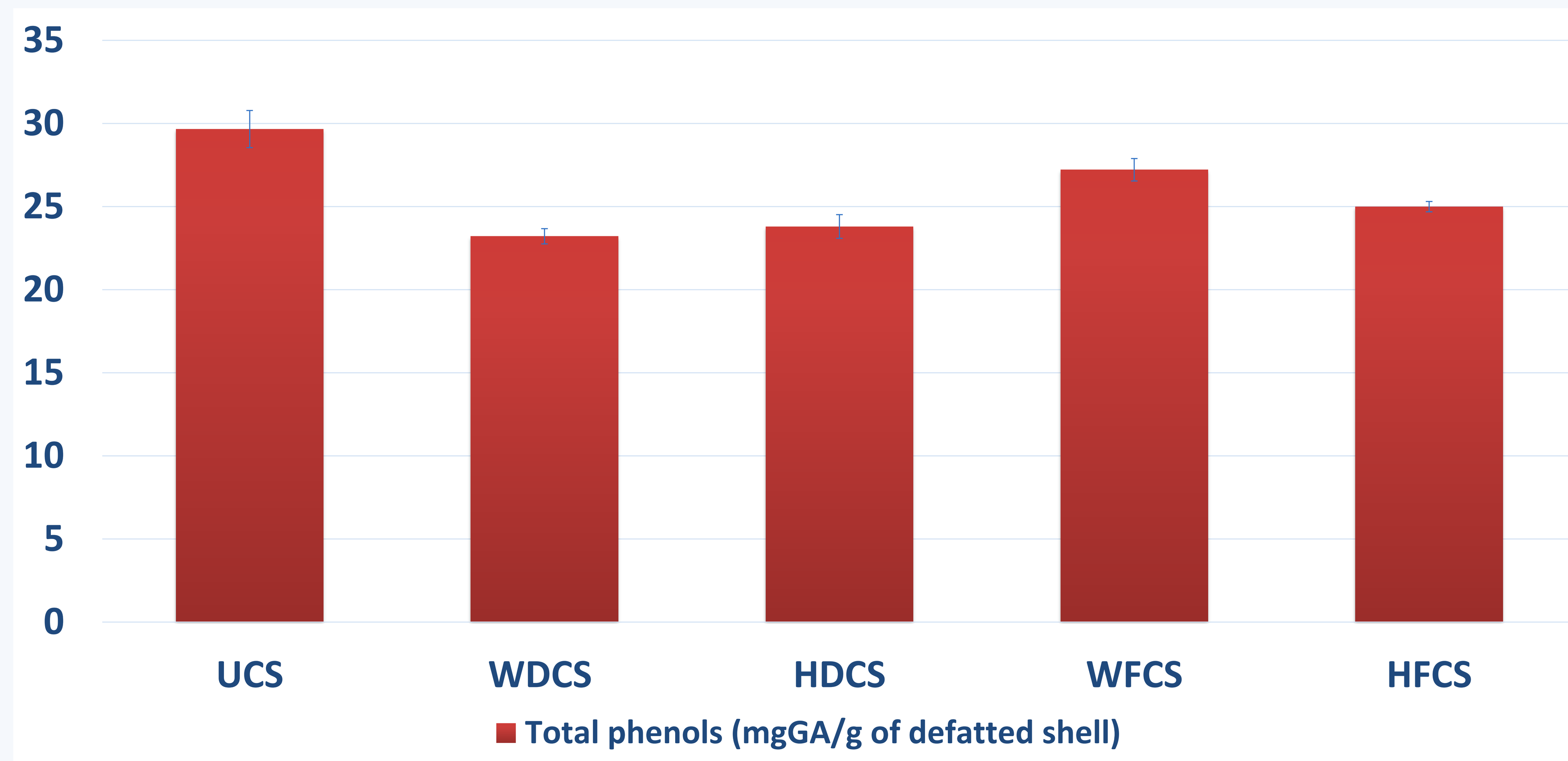

Figure 1. Total phenolic content of cocoa shell samples

Conclusions

- **HVED treated samples had a greater total colour change compared to control samples (Table 1). Oven drying caused a darkening of the samples, while freeze-drying had a brightening effect.**
- **Water activity of control and HVED-treated samples was lower than in untreated cocoa shell (Table 2). Freeze-drying and HVED had an even greater impact on the reduction of these values.**
- **Water and oil binding capacity showed that HVED increased water binding and decreased oil binding compared to control samples (Table 2).**
- **Total phenolic content of cocoa shell decreased with all applied treatments, and freeze-drying was less detrimental for the phenolic components than oven drying (Figure 1).**